

the

CANNON

University of Toronto Engineering Society

SECOND ISSUE

October 5, 1978

High Octane Varsitys

SOLID WASTE MANAGEMENT



ENVIRONMENTAL IMPACT

Penguins Swim North

It has been thought for some time that the best way to understand the immediate environmental effects of a single meteorite impact would be to subject a large, well-exposed and reasonably accessible terrestrial crater to close scrutiny.

In many respects the Manicouagan impact crater in central Quebec is considered the ideal candidate for such a study.

Recent satellite observations of the Manicouagan region, made with the aid of the Skylab and Landsat imaging systems, have revealed the presence of an outer ring with a diameter of 150 kilometers, approximately twice that of the circular trough now filled by the reservoir. This multi-ring aspect of Manicouagan has been compared to the vast multi-ring basins observed on the moon and on Mercury. According to one interpretation, the outermost ring of 150 kilometers marks the limit of the disruption of the bedrock by the shock wave associated with the meteorite's impact, the innermost ring at 35 or 40 kilometers approximates the limit of the initial cavity ex-

cavated by the impact, and the intermediate ring of 65 or 70 kilometers indicates the apparent location of the rim of the crater before it was eroded.

For the past few years an interdisciplinary team of U.S. and Canadian investigators has been conducting detailed field studies of the Manicouagan site. Rock samples were collected at 27 cliffside locations within the Manicouagan melt sheet, a 230-meter-thick annular plateau that surrounds the central peak of shocked, uplifted bedrock. More than 1,000 samples were collected, "resulting in 52 new chemical analyses of major and trace elements as well as several hundred thin sections for petrographic and microprobe analyses." From these data it is now possible to reconstruct the events that formed the Manicouagan structure.

The projectile responsible for the crater fell to the earth some 214 million years ago, striking a target of "relatively dry Precambrian metamorphic rocks overlain by a thin veneer of Ordovician limestone." The large amount of fused rock found at the site (estimated to be as much as 475 cubic kilometers) indicates that the

object "had a high velocity." Assuming that it was a stony meteorite travelling at a typical velocity of 17 kilometers per second, it must have been about eight kilometers across to have yielded the amount of energy needed to melt such a large volume of rock. The impact caused a high-pressure shock wave that propagated rapidly outward from the point of impact, excavating a transient crater between five and eight kilometers deep and between 30 and 44 kilometers across. This initial crater was formed in about five seconds.

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THE CANDU ACHIEVEMENT

cont. from last issue.

Dr. G. A. Pon
Corporate Vice-President,
Engineering, Atomic Energy of
Canada Ltd.

WASTE MANAGEMENT

CANDU technology from its inception has been predicated on "once through" fuelling. Since the nuclear fuels used in other countries' systems con-

How Garbage Can Help Solve The Energy Crisis

Tim Taylor
4th Year Civil

Inspired by the energy crisis of the early seventies, a technological stampede to alternate sources of energy has brought us a veritable smorgasboard of viable means of reducing North America's dependence upon non-renewable fossil fuels.

One offspring from our energy-conscious society is a program to develop energy from urban solid waste. It has been estimated that the average American produces about .9 tonnes of solid waste per year (one can assume Canadian figures are of the same magnitude) and that this figure is growing at an annual rate of 5%. A city the size of Metro Toronto (population assumed to be 2½ million) would therefore produce 2,250,000 tonnes of refuse a year. If 50% of this waste is combustible (as estimated and verified by research at the University of Louisville) 1, then the potential exists for burning 1,125,000 tonnes of refuse each year. (The other 50% of the waste is composed of non-combustible materials such as metals and liquids.) Heat content of the waste varies but, as a general rule, two tonnes of refuse is equivalent to one tonne of average coal. Therefore, Toronto is producing the equivalent of 562,500 tonnes of coal per year which is not being used. At the present cost of \$37.70 per tonne of coal, which is the price Ontario Hydro is currently paying to fuel its generating stations, this is 21 million dollars worth of energy being dumped into Lake Ontario every year.

"Efforts to reclaim energy from solid wastes can be broadly classified into four distinct schemes: direct heat recovery from special incinerators, supplementary fuelling of power plants, destructive distillation (pyrolysis) and an adaptation of present technology to waste heat recovery."

WASTE INCINERATORS

Waste Incinerators are the most traditional and most widely developed method of reclaiming waste as a fuel. Many large incinerators have been built in North America and Europe to provide heat for steam plants, for the desalinating of sea water, and space-heating or air conditioning. These incinerators can be centrally located to receive refuse and distribute steam by a network of pipes similar to water mains.

The major problem with waste incinerators is the variable heat content which can be expected due to wide variation in moisture content of the waste. This forces the incinerator to use either supplementary fuels or guarantee a minimum output, resulting in a loss of economic advantage. (For example, an incinerator in the Netherlands — considered to be the most modern and sophisticated in the world — has a maximum capacity of 55 MW but the minimum guaranteed by contract is only 11 MW).

SUPPLEMENTS TO PRESENT FUELS

A process primarily

cont. on page 2

toin expensive enriched uranium, which is not completely consumed in use, as well as plutonium. reprocessing of fuel has been a much more active issue elsewhere.

Used fuel elements are now being stored under water at Canadian nuclear plants. About fifteen years of generating station experience

ore now available with this type of storage and it has been proven safe and reliable. Since nuclear energy produces less than one pound of waste for every twenty tons from a comparable coal-fired plant, the nuclear wastes produced in Canada are small in volume. All the irradiated fuel produced to date has a total

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OTHER PROVINCES

It was logical that Ontario, with a population of eight million; a concentration of heavy industry, and few undeveloped energy resources except uranium, should have been the first Canadian province to adopt nuclear power.

However, other provinces, as the cost of alternative fuels for electric generation have climbed, are also turning to nuclear power. Quebec is building a 600 MW single CANDU nuclear electric unit at Gentilly, adjoining the site of an earlier experimental 250 MW (e) power plant.

A similar 600 MW CANDU-PHW unit is being built for the New Brunswick Electric Power Commission, at Point Lepreau on the shore of the Bay of Fundy, also for completion in 1980.

Canada's nuclear enterprise involves other provinces as well. Nova Scotia's Cape Breton Island is the site of two heavy water plants, one at Port Hawkesbury, originally built by Canadian General Electric Limited but now operated by AECL, and a plant at Glace Bay, originally built in the 1960s by the Government of Nova Scotia but now completely rebuilt by AECL and back in production.

Manitoba too has an essential part of Canada's nuclear effort at Whiteshell Nuclear Research Laboratories, where important work has been done in developing an experimental organic cooled reactor, and where Canada's research into disposal of reactor wastes is now centered.

In fact, with the high proportion of Canadian content in

each nuclear station, there is not a province in Canada that has not provided some resource for Canada's nuclear effort. This will increase, with the size of this program. As fossil fuel supplies dwindle and hydro sources become developed, various provinces will be seriously evaluating the nuclear option. In a recent address to the Canadian Community Newspapers Association, Robert Bonner, British Columbia Hydro chairman, stated that major nuclear development is unavoidable in Canada. He added: "The exotic alternatives so dear to the

tion of other countries as soon as NPD began operating successfully in the 1960s. The CANDU technology was seen as uniquely appropriate for countries of intermediate industrial and economic capability, with their own supplies of mineable uranium, who desired a nuclear power program not tied to the import of fissionable material from one of the great powers. Producing heavy water is simpler than enriching uranium. It is also required only one in a reactor's lifetime (except for small quantities to make up for losses), as opposed to a continuing requirement for enriched fuel.

Committed and Planned Canadian Nuclear Power Stations

Station	Unit	Unit Rating	Power MW(e) net	System	First Operation
NPD	1	22	O.H. ¹	1962	
Douglas Point	1	208	O.H.	1966	
Pickering 'A'	4 x	514	O.H.	1971-73	
Gentilly-1	1	250	H.Q. ²	1971	
Bruce 'A'	4 x	750	O.H.	1976-79	
Gentilly-2	1	600	H.Q.	1980	
Lepreau	1	600	NBEPC ³	1980	
Pickering 'B'	4 x	514	O.H.	1981-83	
Bruce 'B'	4 x	750	O.H.	1983-86	
Darlington	4 x	800	O.H.	1986-88	
unnamed	1	600	M.H. ⁴	1985+	

1. O.H. — Ontario Hydro
2. H.Q. — Hydro Quebec
3. NBEPC — New Brunswick Electric Power Commission
4. M.H. — Manitoba Hydro

hearts of protesters and writers of popular articles can not make a serious impact upon the energy supply problems for at least ten years".

EXPORTS

The development of the CANDU system attracted the attention

A nuclear station of 125 MW (e) capacity was completed at Karachi, Pakistan by Canadian General Electric in 1971, while AECL assisted the Indian Atomic Energy Commission to build a station of 200 MW (e) capacity in Rajasthan, RAPP-1, which went on power in 1972. India is presently building five more stations similar to RAPP with her own resources.

centre was accelerated to a speed of more than three kilometers per second.

The next stage of the cratering process involved the flow of melt and rock in dissipating their momentum and internal energy after the first few seconds of the passage of the shock wave. At first the debris flowed downward and outward more or less equally, but the compressibility limit of the bottom was soon reached and the flow became predominantly outward. Eventually the melt flowed far enough radially to form a "lining" on the less shocked materials at the edge of the cavity. At the bottom rocks subjected to peak pressures in the 200-to-400-kilobar range remained in place, whereas the sides of the excavation rocks fractured by pressures of less than 50 kilobars were ejected.

Besides adding internal energy to the rocks by heating, fracturing and melting them, the shock wave transmitted the meteorite's momentum to the earth, propelling material generally downward and outward in a spherical pattern centered on a point a kilometer or so below the surface under the impact point. The melted material near the

These effects set up complex motions that mixed less shocked material into the superheated melt. Blocks ranging up to tens of meters in size were incorporated, with the bulk of the material being in the submillimeter range. As



the melt approached the edge of the cavity, it incorporated less shocked clasts: bodies at temperatures lower than 100 degrees C. The remnants of these clasts were preserved and can be seen today in the rock samples. The time required for the completion of

Canada is presently supplying engineering, materials and equipment for two other stations, of 600 MW (e) unit size, one in the state of Cordoba, Argentina, and one at Wolsung, on the east coast of the Republic of Korea.

While trade in nuclear power plant and technology has been criticized because a universal concern about proliferation of nuclear weapons, it has remained Canadian policy to disseminate the benefits of the peaceful uses of atomic energy. However, Canada has made the observance of nuclear safeguards a condition of all exports of nuclear equipment, technology, or fuel materials.

Another thrust of AECL research is to develop potential improvements on the CANDU fuel cycle. The good neutron economy of CANDU permits the exploitation of thorium, an element three times as common as uranium. Utilization of thorium in CANDU would transform it into U-233, a fissile isotope of uranium. By reprocessing the spent fuel, such a cycle could be built up so that, at equilibrium, it would breed most of its own fissionable fuel, requiring only small additions of thorium into the cycle, and no more uranium. This is considered by many a superior strategy to the use of plutonium-fuelled "breeder" reactors, now being developed in the U.S. and Europe. However, as said earlier, the decision on fuel reprocessing must first be made.

THE FUTURE

Ontario is continuing its program of four reactor generating stations, at Pickering "B", Bruce "B", and Darlington which will more than double Ontario Hydro's nuclear capacity by the late 80s. Engineering studies are being carried out for a 1250 MW (e) unit which, if adopted

the outward-migration phase of the melt was "at most a few minutes."

The members of the Manicouagan study group responsible for analyzing the petrogenesis of the melt sheet estimate that it took roughly

by Ontario Hydro, would also be built in a four-unit station. It is estimated that by the end of the century there will be about 100 nuclear electric generating units across Canada, with a total capacity of about 80,000 MW (e) — equivalent to Canada's total electric generation capacity at present.

THE CANDU ACHIEVEMENT

The CANDU achievement over the past 20 years has been based on a unique pattern of co-operation between utilities, government agencies, and the private manufacturing sector. The CANDU reactor has a solid and unsurpassed record of safe, and cost-effective operation. The total development cost of the CANDU system, including demonstration and prototype reactors, is estimated at between one and two billion dollars (depending upon what items are included as development expense). This is roughly comparable to what has already been spent in the U.S.A. on a single reactor concept — the fast "breeder" — which has to date produced no useful power.

The U.K. and France have already admitted that reactors built according to their original national concepts are obsolescent, and are turning to U.S. style light water reactors, which other European countries and Japan already employ.

It may be considered then, that the U.S. and Canada have the only two notional nuclear programs which have stood the test of time.

The CANDU program is a monument to the dedication and skill of Canadian scientists, government leaders, and industrial and utility management. It will continue to be a major component of the world's effort to increase the application of nuclear energy in the service of man.

directly on undigested remnants of clasts." Thereafter the viscosity of the melt increased rapidly "because large blocks, some tens of meters across, did not sink or float." During this period the bottom of the cavity was rising and the margins of the excavation were slumping; these motions apparently took place while the melt was still fluid enough to flow around breaks in the basement.

The investigators reckon that 1,600 more years were required to complete the crystallization of the melt sheet at Manicouagan. The crystallization front moved in from the sides of the crater, reaching a distance of 10 meters in about 35 years. During the final cooling phase, the melt was "apparently prevented from convecting by the rapidly nucleated crystals."

"The chemical, isotopic and thermal-balance studies on the Manicouagan melt rocks amply illustrate some of the processes of impact melting. These studies and the geophysical and structural data from Manicouagan have provided constraints and models of the impact process that can be used and tested in further investigations at other craters and on other planetary surfaces." *Scientific American*

WE HAVE A FEW QUESTIONS:

- (1) Have you recently read any interesting engineering-related articles in magazines, journals, etc.?
- (2) Are you writing a thesis?
- (3) Do you know any engineers?
- (4) Do you have any special engineering-related hobbies or interests?

If you answered "yes" to any of the above questions, we're counting on you to write for the Cannon.

The Cannon needs articles for all departments - from major illustrated technical reports to short Diversions. So if you have anything of interest to other Engineers, let us know. The Cannon is your paper - your participation will guarantee its success.

The Cannon is distributed on Thursdays, whenever the Toke isn't. Deadline for copy is 5:00 PM Monday. Articles should be typed. The Cannon offices are on the third floor of the old Metro Library, across the aisle from the stores.

FIRSH

BT2

If your FIRSH card is stamped with all the appropriate stamps, for Orientation as outlined in your FIRSH Kit, you are entitled to a FREE U of T Engineering

T-SHIRT

Present yourself at the Stores on or after Tuesday, October 10 with your card.

ATTENTION ALL COMMITTEE ORGANIZATION AND CLUB CHAIRMEN

The Cannon is a publication that is designed to keep all of our Engineering faculty informed as to the goings on around Campus. Since the vast majority of the student population in our faculty don't know the full extent of or even the purpose of various organizations, clubs and committees, the Cannon would be an ideal way to publicize the activities and events that will occur.

As well as this, all relevant committee and club internal affairs can be reported on within these pages.

Accordingly, anyone wishing to submit interesting articles relevant to the above is welcome to, as this would be greatly appreciated by the entire student body.

All submissions should be put in the Cannon Mailbox no later than the Monday before publication.

DIVERSIONS

by Bramer Kgnort

Should you be faced with another dull tutorial in a room on the north side of the Galbraith building or facing into the court yard of the same building, take heart! Working from either the third or fourth floor, it is possible to launch an airplane (paper of course) into some of the best updrafts on campus. Naturally the kind of airplane required to take advantage of these updrafts will not be your average paper dart style. Something with a large surface area to weight ratio is needed. I suggest two such designs:

The first starts with a strip of paper about an inch wide, and eight and a half inches long (a convenient length). Fold the strip in half and remove a notch about a quarter inch square, half an inch from each end. The notches have to be on opposite sides of the strip to produce a hole in the unfolded strip at one end and a tee shape at the other. Push the tee through the hole and spread the paper out to its full width. Viewed from the paper's edge the result should look similar to the outline of a fish. Upon launching this 'plane' see that it is spinning around an axis through the "tail" and the 'head' in order to give it in-flight stability. If the winds are right the results will be impressive. Some even manage to make it across St. George much to the surprise of unwary food vendors.

FISH PLANE

NOT TO SCALE



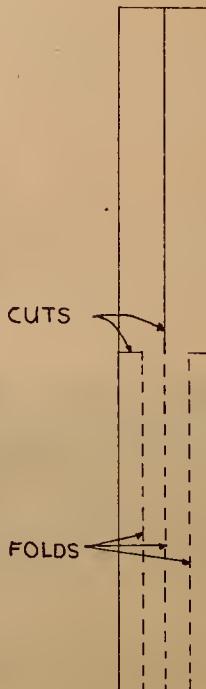
ASSEMBLED PROFILE



The second design is a

helicopter style that like the first, starts with a strip of paper 1 inch by 8 1/2 inches folded along the long axis. It is necessary to cut the fold from one end to a point one third of the way along the strip. At the end of this cut and perpendicular to it, it is necessary to make two cuts that extend from the outside edges of the unfolded paper one quarter of the strip width in. With these cuts made, it is possible to fold the paper at the cut end of the strip on itself twice, the first fold wrapping the outside quarters on the inside quarters and the second fold bringing the remaining quarters in contact with each other. The loose unfolded strips at the cut end form the propeller blades and must be folded to hang slightly elevated from perpendicular to the body of the helicopter when it is in flight (test this with a few trial flights). To start them in flight these helicopters are just dropped after which the blades will start spinning. Spinning slows the rate of descent of the helicopter and in the slightest updraft the rate becomes negative. In fact these rather fragile contraptions have been known to stay in flight for extended periods (over three minutes in this author's experience). Story has it that one unusually well designed model was seen flying over Convocation Hall in the direction of Queen's Park. Wouldn't Bill Davis be surprised to learn that despite of his government's cutbacks, Engineering is alive and well at U of T.

HELICOPTER



IN-FLIGHT PROFILE



ENGINEERS! START PLANNING NOW FOR SUMMER JOBS IN '79

1. Check Placement Centre bulletin boards from early October so as not to miss out on opportunities with large national employers recruiting on campus

2. Be prepared - attend our resume and interview seminars offered regularly during the school year. Success in job hunting isn't all luck!

3. Start planning your own job search. Our Career Library contains many employer directories and lists by discipline of companies that have advertised summer jobs with us in the past.

GET A HEAD START AND ACT NOW!!

Career Counselling & Placement Centre
344 Bloor St. W., 4th Floor
(just west of Spadina)

BLUE AND GOLD

COMMITTEE MEETING - 5 P.M. -

THURSDAY OCTOBER 5th in the STORES

RESUME & INTERVIEW PREPARATION

Thursday, October 5
5-7 P.M.

Sidney Smith Rm. 2135

guest employer/lecturer: Mr. B. Watson
DOFASCO

THE BLUES SECOND HOME GAME against the University of Windsor Lancers takes place this Saturday at 2:00 PM in Varsity Stadium. Student Admission is \$1.50. See you at the game!